

CLAIMS

We claim:

1. A capillary seal comprising a shield affixed to and defining a channel with a stationary component, wherein:

the stationary component defines a bore in which a rotatable component is supported for rotation relative to the stationary component, adjacent surfaces of the rotatable component and the stationary component defining a bearing gap having fluid there between;

at least a portion of the channel is in fluid communication with the bearing gap fluid;

the shield extends generally radially toward the rotatable component defining an annulus separating the shield and an outer surface of the rotatable component;

the shield defines a fill hole for filling fluid and passing air through the shield; and

the stationary component includes a fill pool situated adjacent to the fill hole, the fill pool forming a diverging angle with the shield.

2. The capillary seal as in claim 1, wherein:

at least one of the adjacent surfaces of the shield and the stationary component axially diverge with increasing distance from the rotatable component; and

the surface of the fill pool diverges from the shield at an angle greater than the adjacent diverging surfaces of the shield and the stationary component for creating an unstable area for any fluid in the fill pool, wherein the fill pool is one of conical or spherical in shape.

3. The capillary seal as in claim 2, wherein the angle of divergence of the adjacent surfaces of the shield and the stationary component is about 2 degrees, and the angle of divergence of the fill pool from the shield is about 30 degrees.

4. The capillary seal as in claim 2, further comprising:

a first fluid meniscus formed within the annulus; and

a second fluid meniscus formed within the channel defining a fluid reservoir arched at least partially about a periphery of the fill pool, and defining an air plenum situated apart from the arch,

wherein the steeper divergence angle of the fill pool creates a force gradient to pull any fluid from the fill pool to the second fluid meniscus.

5. The capillary seal as in claim 2, further comprising a third fluid meniscus formed within the fill pool during one of fluid filling through the fill hole or during a shock event, wherein the divergence angle of the fill pool creates a force gradient to pull the third fluid meniscus from the fill pool.

6. The capillary seal as in claim 1, wherein the rotatable component is one of a shaft or a conical shaft, and the stationary component is a sleeve.

7. The capillary seal as in claim 4, wherein the fluid is circulated through the bearing gap and through a portion of the fluid reservoir, air being expelled to the air plenum and through the fill hole, and further comprising pumping grooves formed on at least one of adjacent surfaces of the rotatable component and the stationary component.

8. The capillary seal as in claim 1, wherein the shield and channel surfaces further extend generally axially at a position distal from the rotatable component.

9. The capillary seal as in claim 1, wherein the annulus radial width is between 0.015 mm and 0.03 mm, the axial width of the channel proximal to the rotatable component is about 0.08 mm, and the axial width of the channel distal from the rotatable component is about 0.1 mm.

10. A fluid dynamic bearing system comprising a sleeve defining a bore in which a shaft is supported for rotation relative to the sleeve, adjacent surfaces of the sleeve and shaft defining a bearing gap having fluid there between, and a shield affixed to and defining a channel with the sleeve, wherein:

at least a portion of the channel is in fluid communication with the bearing gap fluid;

the shield extends generally radially toward the shaft defining an annulus separating the shield and an outer surface of the shaft;

the shield defines a fill hole for filling fluid and passing air through the shield; and
the sleeve includes a fill pool situated adjacent to the fill hole, the fill pool forming a diverging angle with the shield.

11. The fluid dynamic bearing system as in claim 10, wherein:
at least one of the adjacent surfaces of the shield and the sleeve axially diverge with increasing distance from the shaft; and
the surface of the fill pool diverges from the shield at an angle greater than the adjacent diverging surfaces of the shield and the sleeve for creating an unstable area for any fluid in the fill pool, wherein the fill pool is one of conical or spherical in shape.
12. The fluid dynamic bearing system as in claim 11, wherein the angle of divergence of the adjacent surfaces of the sleeve and the shield is about 2 degrees, and the angle of divergence of the fill pool from the shield is about 30 degrees.
13. The fluid dynamic bearing system as in claim 11, further comprising:
a first fluid meniscus formed within the annulus; and
a second fluid meniscus formed within the channel defining a fluid reservoir arched at least partially about a periphery of the fill pool, and defining an air plenum situated apart from the arch, wherein the steeper divergence angle of the fill pool creates a force gradient to pull any fluid from the fill pool to the second fluid meniscus.
14. The fluid dynamic bearing system as in claim 11, further comprising a third fluid meniscus formed within the fill pool during one of fluid filling through the fill hole or during a shock event, wherein the divergence angle of the fill pool creates a force gradient to pull the third fluid meniscus from the fill pool.
15. The fluid dynamic bearing system as in claim 10, wherein the shaft is a conical shaft.

16. The fluid dynamic bearing system as in claim 13, wherein the fluid is circulated through the bearing gap and through a portion of the fluid reservoir, air being expelled to the air plenum and through the fill hole, and further comprising pumping grooves formed on at least one of adjacent surfaces of the shaft and the sleeve.

17. The fluid dynamic bearing system as in claim 10, wherein the shield and channel surfaces further extend generally axially at a position distal from the shaft.

18. The fluid dynamic bearing system as in claim 10, wherein the annulus radial width is between 0.015 mm and 0.03 mm, the axial width of the channel proximal to the shaft is about 0.08 mm, and the axial width of the channel distal from the shaft is about 0.1 mm.

19. A method comprising:

forming a diverging channel with one of a relatively rotatable component and a stationary component, adjacent surfaces of the rotatable component and the stationary component defining a bearing gap having fluid there between, wherein at least a portion of the channel is in fluid communication with the bearing fluid;

forming a fill hole through the stationary component for filling fluid and passing air from the bearing fluid;

forming a fill pool, situated adjacent to the fill hole, having a diverging angle with a surface of the channel, the diverging angle being steeper than the channel, for creating an unstable area for any fluid in the fill pool.

20. The method as in claim 19, further comprising forming a first fluid meniscus within the channel defining a fluid reservoir arched at least partially about a periphery of the fill pool, and defining an air plenum situated apart from the arch, wherein the steeper divergence angle of the fill pool creates a force gradient to pull any fluid from the fill pool to the first fluid meniscus.

21. The method as in claim 19, further comprising forming a second fluid meniscus within the fill pool during one of fluid filling through the fill hole or during a shock event, wherein the

divergence angle of the fill pool creates a force gradient to pull the second fluid meniscus from the fill pool.

22. The method as in claim 19, further comprising creating a force gradient, utilizing the divergence angle formed at the periphery of the fill pool, to retain any fluid within the channel during and following a shock event of at least 1000 G to the channel.